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Interim Status Report

DOD University Research Instrumentation Program

LASER STUDIES OF ION COLLISION DYNAMICS

Grant Monitor: Capt. Lee Myers
Program Director
Chemical and Atmospheric Sciences
Air Force Office of Scientific Research
Bolling Air Force Base
Washington, D. C. 20332

Principal Investigator: Stephen R. Leone
Department of Chemistry and
Joint Institute for Laboratory Astrophysics
University of Colorado
Boulder, Colorado 80309

Co-investigator: Veronica M. Bierbaum

Grant No. AFOSR-84-0210

Start Date: July 15, 1984

Amount: $102,500

Cost Sharing: $5,000

Interim Report

The cw ring dye laser system specified in this grant was purchased and fully installed and operational in December 1984. The items of equipment procured were a Coherent Radiation model Innova 20 argon ion laser, a Coherent Radiation model CR699-21 ring dye laser, and a Coherent Radiation model 240PP-2 spectrum analyzer. The acquisition cost of all the items for the total bid package required the full $102,500, FOB Boulder and completely installed. Coherent Radiation did negotiate to give a price reduction in the amount of three per cent over their list prices. However, because of price increases it was not possible to obtain the wavemeter which was specified in the original grant proposal as part of these instrumentation funds.

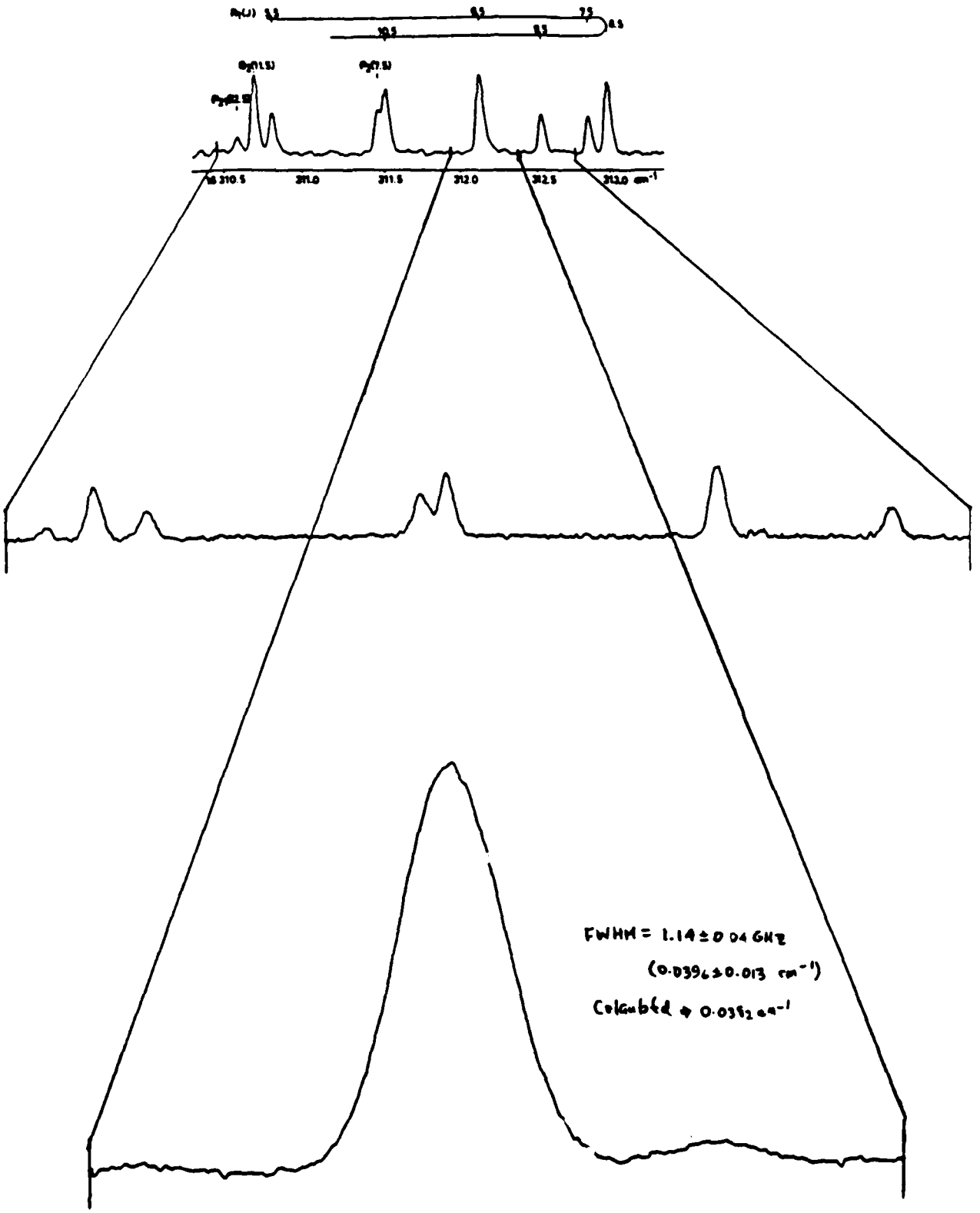
The University of Colorado provided the cost of the installation of the 480 V power for the laser system. This cost also exceeded the original estimate of $5,000 by a few thousand dollars, in spite of the fact that a custom-manufactured transformer and panel were donated by the Joint Institute for Laboratory Astrophysics. The additional cost was generously absorbed by the University.

The new laser system has been successfully coupled to the flow-drift apparatus, and signals of excellent quality and signal-to-noise have already been obtained. A detailed discussion of the experimental results thus far were incorporated into the major renewal proposal recently submitted to AFOSR on this work. Here only a brief summary of that discussion will be included.

The enclosed figure shows a narrow slice of the laser-induced fluorescence spectrum for the $N_2^+(A^2\Pi_u - X^2\Sigma_g^+)$ transition obtained in preliminary experiments at thermal energy with this newly coupled laser system. The (4,0) transition is excited and the (4,1) fluorescence is

monitored. The signal-to-noise is excellent, even though a number of experimental parameters have not yet been optimized. The upper portion of the figure shows a published spectrum in the same region for comparison (from T. A. Miller, T. Suzuki, and E. Hirota, J. Chem. Phys. 80, 4671 (1984)). The observed Doppler linewidth (0.0396 cm^{-1}) is in good agreement with the calculated Doppler width (0.0382 cm^{-1}). It is clear that a tremendous improvement has already been achieved over our previous capabilities with the pulsed laser detection, and that the ultimate sensitivity will be exceptional.

Plans are now being made to begin measurements in the well-characterized electric field drift section of the flow tube, as outlined in more detail in the renewal proposal document.



Portion of laser-induced fluorescence spectrum of the $N_2^+(A^2\Pi_u\text{-}X^2\Sigma_g^+)$ system near the R_1 bandhead. Top spectrum is from Miller, et al.; middle and bottom spectra represent recent results from our laboratory.